

mandated in Section 319 of the Water Quality Act of 1987. It is recognized, however, that the time needed to demonstrate water quality improvements may often exceed four years.

The approach of controlling NPS pollution in the Albemarle-Pamlico estuarine area (and throughout North Carolina) is through a combination of land-use controls and technology-based BMPs. In urban areas, the preferred method of treatment is land use control through low-density development because of the long-term maintenance requirements associated with structural BMPs. In situations where low-density development is not feasible, stormwater controls devices (BMPs) are allowed. Nonpoint source strategies for other categories of pollution (e.g., agriculture, construction, or mining) depend more on the implementation of BMPs such as setbacks or filter strips, and waste reduction/management systems. The installation of these BMPs and management systems may be voluntary or required by regulations.

C. EVALUATION OF TRENDS

C. 1. Historical Perspective and Current Trends

C. 1. a. General Statement. Accelerated nutrient loading, particularly over the past 2 to 3 decades, has ushered in some ominous and increasingly common symptoms of eutrophication which, to the best of our knowledge, were extremely rare prior to World War II. Prior to the late 1960s virtually no field surveys yielding quantitative data on nitrogen and/or phosphorus concentration or loading characteristics can be documented for North Carolina's coastal waters, including major river systems and estuaries.

Several early reports describe hydrologic, hydrographic, and very limited chemical characteristics of specific waters (Dubach 1977). The first extensive field surveys specifically oriented towards identifying concentrations, sources and sinks as well as some bio-geochemical cycling characteristics of nitrogen and phosphorus occurred in the 1960s and 1970s (Copeland and Hobbie 1972; Hobbie et al. 1972; Harrison and Hobbie 1974; Kuenzler et al. 1982) for the Pamlico River Estuary. Bowden and Hobbie (1977) initially described nutrient characteristics of the Albemarle Sound, Hobbie and Smith (1975) examined nutrients in the Neuse River, while Stanley and Hobbie (1977) reported on nitrogen cycling in the lower Chowan River.

During the mid 1970s the NC Division of Environmental Management and the US Geological Survey developed and deployed monitoring networks in coastal regions that included nutrient analyses. Relevant river and estuarine systems included were the Chowan-Albemarle, Roanoke, Tar-Pamlico and Neuse. Throughout the 1970s and early 1980s more specific and goal-oriented nutrient/eutrophication studies on these systems and their watersheds were initiated. Included were examinations of nutrient uptake kinetics of phytoplankton in the Pamlico (Kuenzler et al. 1982), Chowan (Stanley and Hobbie 1977; Kuenzler et al. 1982), and Neuse (Stanley 1983) Rivers, and determinations of algal growth requirements including nutrient limitations through the use of bioassays in the Chowan (Witherspoon et al. 1979; Sauer and Kuenzler 1981; Paerl 1982a, 1982b) and Neuse (Paerl 1983) Rivers.

Origins, processing, and runoff characteristics of agricultural field sites were likewise investigated by Gilliam et al. (1978), while Kirby-Smith and Barber (1979) evaluated the potential estuarine water quality impacts of converting forest to intensive agriculture, with particular reference to nutrient discharge alterations. Skaggs et al. (1980) have more recently monitored effects of land development on the chemical characteristics of drainage water in Eastern North Carolina. Matson et al. (1983) and Kuenzler et al. (1984) examined biogeochemical processing and cycling of nitrogen and phosphorus compounds in sediments of the Neuse Estuary, while Kuenzler et al. (1982) addressed similar questions in the Chowan River. Meanwhile, water quality models (based in large part on nutrient dynamics) were being developed for the Chowan (Amein and Galler 1979) and Pamlico (Lauria and O'Melia 1980)